



Structure and strength in graded nanostructured steel

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Session: L2, Venue: Palma (Room: E, F)

NANOMATERIALS FOR STRUCTURAL & ENERGY APPLICATIONS II

Session Chairs: F Rizzo, Brazil and Ivani Bott, Brazil

L2 Dec-02 14:10

*Structure and strength in graded nanostructured steel

Xiaodan Zhang, Niels Hansen, Yukui Gao, Xiaoxu Huang[†]

Danmarks Tekniske Universitet, Denmark

L2 Dec-02 14:30

*Nd–Fe–B and Sm–Co/Fe exchange–spring films–model hard magnetic materials for electric power generation

Yuepeng Zhang[†], Charudatta M. Phatak, John E. Pearson, Yongseong Choi, Jidong S. Jiang, Nora M. Dempsey, Dominique Givord, Sakura Pascarelli

Argonne National Laboratory, United States of America

L2 Dec-02 14:50

*Formation and characterization of hybrid nanodots embedded in gate dielectric for optoelectronic application

Seiichi Miyazaki[†]

Nagoya University, Japan

L2 Dec-02 15:10

*Nano-scale film surface control by advanced sputtering system

Hiroataka Toyoda[†]

Nagoya University, Japan

L2 Dec-02 15:30

*Multi–component nanoarchitectures comprised of inorganic and carbon nanostructures

Nitin Chopra[†]

University of Alabama, United States of America

Coffee / Tea break 15:50 to 16:10 |

L2 Dec-02 16:10

*Preferential oxidation of CO in hydrogen on PtCu nano particles supported on alumina

Takayuki Komatsu[†], Michiko Takasaki, Shinya Furukawa, Kenichi Ozawa

Department of Materials Science, Tokyo Institute of Technology, Japan

L2 Dec-02 16:30

*Crystal chemistry of rare earth–borides with dimensional network structures

Kunio Yubuta[†]

Institute for Materials Research, Tohoku University, Japan

L2 Dec-02 16:50

*Nanostructure control of Si–based solar cells using plasma CVD

Masaharu Shiratani[†], Giichiro Uchida, Hyunwoong Seo, Kazunori Koga, Naho Itagaki, Kunihiro Kamataki

Kyushu University, Japan

L2 Dec-02 17:10

*Antiferromagnet material for low–power consumption magnetic recording devices

* *invited presentation*

Structure and strength in graded nanostructured steel

Xiaodan Zhang¹, Niels Hansen¹, Yukui Gao², Xiaoxu Huang¹

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The structure and strength of low carbon steel samples have been analyzed after plastic deformation by shot-peening and cold-rolling. The fine scale surface microstructure caused by shot-peening extends to $\sim 50\text{ }\mu\text{m}$ below the surface. The structure is graded and subdivided by dislocation boundaries and high angle boundaries showing a clear resemblance to the lamellar structure, which evolves during conventional rolling of bulk metallic materials from medium to high strain. As the surface is approached, the boundary spacing decreases to $\sim 50\text{ nm}$ at the surface. In parallel, the misorientation angle across boundaries increases to $\sim 65\%$ of high angle boundaries. The cold-rolled steel shows a low hardening rate at high strain and by assuming additive strength contributions from Hall–Petch and dislocation strengthening, the flow stress has been expressed by the relationship $\sigma - \sigma_0 = k_2 D_{av}^{-0.5}$, where D_{av} is the average spacing between the low and high angle boundaries which subdivide the microstructure, σ_0 is the friction stress and k_2 is a number which is expressed in terms of structural parameters which have been determined by electron backscattered diffraction. It is found that calculated k_2 values are in accord with an experimental value of $310\text{ MPa }\mu\text{m}^{0.5}$. In the shot-peened steel the increase in D_{av} with increasing distance from the surface is transformed into a stress profile based on the $\sigma - D_{av}$ relationship established for cold-rolled bulk samples. The calculated stress profile is validated by comparison with the experimental profile based on hardness measurements, and good agreement is found. This result points to a wider application of the suggested method to derive the local flow stress in a deformed microstructure based on a measurement of the local boundary spacing and the stress–structure relationship for the bulk material in the deformed state.

Reference:

[1] Hall–Petch and dislocation strengthening in graded nanostructured steel. Xiaodan Zhang, Niels Hansen, Yukui Gao, Xiaoxu Huang. *Acta Materialia* 2012; 60: 5933 - 5943.